Impact Analysis of LEO Hyperspectral Sensor IFOV size on the next generation NWP model forecast performance

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Motivation

To assess the forecast impact obtained from the assimilation of next generation CrIS observations with increased spatial resolution in a high resolution global model.

1. Observing Simulation System Experiment (OSSE)

- Aim to assess the impact of a hypothetical data type on a forecast system.
- Methodology (Figure 1)
  - Nature run.
  - Simulate existing observations.
  - Control run assimilating simulated existing observations.
  - Calibration.
  - Simulate candidate observations.
  - Perturbation run with the addition of simulated candidate observations.
  - Comparison of forecast skill between the control and perturbation run.

2. Nature Run (NR)

- A long, uninterrupted forecast generated by state of the art numerical weather prediction (NWP) model at the highest resolution possible.
- NASA GEOS-5 NR
  - Horizontal resolution: 7km.
  - Number of vertical levels: 72 extending up to 0.01hPa.
  - Period covers May 2005 to May 2007 (30 minutes write-out).

3. Simulation of conventional observations for existing observing systems

- Noise free rawinsondes, surface, profiler, scatterometer and GPSRO data simulated based on the location and time considered stored in BUFR files used by operational GFS for the same date.
- Nearest time step, bilinear interpolation in the horizontal and log-linear interpolation in the vertical.
- Surface pressure and station elevation follows NR topography.
- GPSRO uses 2D bending angle forward model from EUMETSAT Radio Occultation Processing Package. (Figure 2 shows comparison between simulation and observed).
- Errors added to simulated observations
  - Rawinsonde : vertically correlated errors added to T, q, u and v component of winds.
  - Other datasets – Non-correlated Gaussian random errors with standard deviation based on GSI observational error table.

4. Simulation of satellite observations for existing observing systems

- Flying satellites in the NR.
- Simulated radiances using CRTM 2.1.3 for the following sensors:
  - (a) AMSU-A on NOAA-15, NOAA-18, NOAA-19, METOP-A, METOP-B and AQUA
  - (b) MHS on NOAA-18, NOAA-19, METOP-A and METOP-B
  - (c) HIRS-4 on METOP-A
  - (d) AIRS on AQUA
  - (e) IASI on METOP-A and METOP-B
  - (f) CrIS on S-NPP (Figure 4)
  - (g) ATMS on S-NPP
- Orbit simulator - Generate sensor geometry for the above list of sensors to be used for radiance simulation at any given set of start and end time. See Figure 3 for comparison between real and simulated orbits.
- Errors added to simulated satellite observations – sum of Gaussian random error with standard deviation based on sensor NEDT and forward model error. No spatial and spectral correlations.

5. Assimilation System, NWP model and its configuration

- GFS (mode) revision r44713 and GSI revision r42096
- Global @ T1534 (~13km)
- 80 Ensemble members

6. Experimental Design

- Data denial experiments, model and bias correction spin-up: 1 April to 14 May 2014
- Calibration: 15 – 31 May 2014.
- Data type denied for calibration comparison are rawinsondes (Ps, T, q and uv), METOP-B AMSU-A and AIRS.

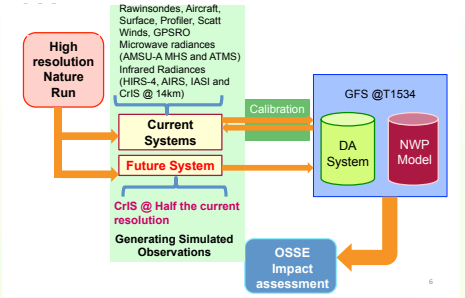
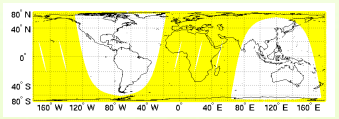
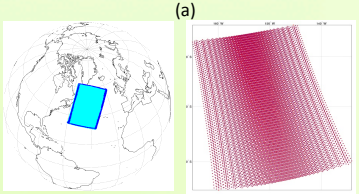


Figure 1 Components of OSSE for Next Generation CrIS



(a)



(b) (c)

Figure 3 (a) Orbits of observation ingested into GSI in a 6-hour window generated by the orbit simulator, (b) comparison of simulated satellite orbit in blue and real satellite orbit coverage in cyan valid for the same start and end time, (c) comparison of simulated FOV locations in red and real FOV locations in blue.

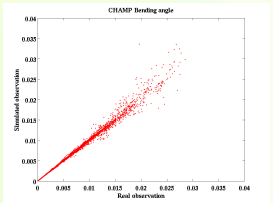


Figure 2 Comparison of simulated and observed bending angle for CHAMP at he start of the NR.

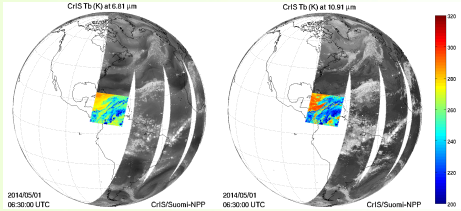
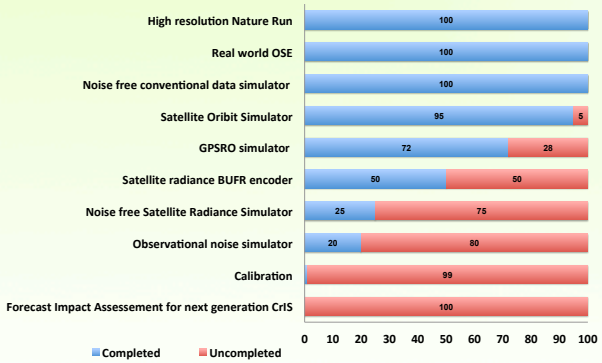


Figure 4 Simulated S-NPP CriS BT from CRTM using inputs from NR and orbit simulator for water vapor channel (left) and surface channel (right).

7. Progress from July 2014 to March 2015



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